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13. ABSTRACT *(Maximum 200 words)*

The goals of the proposed research are to: 1) determine the regions within the water column that have the highest variability in optical and hydrographic parameters as a function of total water depth, 2) determine the likely physical and biological forcing mechanisms associated with observed variability. We have combined the measurement of the inherent optical properties and physical properties onto a single platform. This platform allows us to make simultaneous, detailed vertical profiles of optical and hydrographic parameters. In the shallow waters of thelittoral environment this system can be used to make vertical profiles as often as every two minutes. This system was used to collect over 600 vertical profiles at Oceanside, California during October 1995. The sampling patterns include 3 transect lines perpendicular to the beach, a long time series at a single station, and 2 one hour time periods with intensive profiling at a single station. The profiling data is to be combined with the profiling and mooring data of Drs. Weidemann and Johnson of NRL to provide a comprehensive data set of optical and dynamic parameters. We propose to work with Drs. Weidemann and Johnson in the analysis of the combined data sets.

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Final Technical Report

VARIABILITY OF OPTICAL PROPERTIES WITHIN THE LITTORAL ENVIRONMENT

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GOAL

The goal of this study is to understand which regions within the water column have the highest optical variability and which forcing mechanisms are responsible for the variability.

OBJECTIVES

The objectives of this study are to address the following questions:

- What is the vertical variability in optical properties over time scales of a few minutes to 10 days?
- How does the total water depth affect the variability?
- What portion of the optical variance is associated with internal waves, tides, wave height and period, wind forced mixing, and biological productivity?
- Under what forcing conditions is the optical variability the highest?

APPROACH

As part of a collaborative study with the Naval Research Laboratory (NRL), we participated on a comprehensive Littoral Optics Experiment (LOE) field study conducted off Oceanside California in 1995. Our contribution to this program was the measurement of inherent optical properties coincident with hydrographic measurements at 17 stations in a 3 km by 3 km study area. Over 600 profiles of optical and hydrographic data were collected during the study. The data that we collected has been combined with optical, hydrographic, and meteorological data collected by researchers at NRL. By averaging the profiles into depth bins and density bins we can look at the temporal and spatial changes at fixed depths and along density surfaces.

WORK COMPLETED

All profiles have been averaged into depth and density bins. Three profiles were normally collected at each station. The binned data from each of the profiles was combined to determine the average and standard deviation of the optical properties in a 10-minute period. When stations were occupied more than one time a day the profiles were combined to provide statistics for the day. The daily statistics were combined to provide statistics of the optical variability over the length of the cruise.

We aided in the analysis of airborne optical imagery collected by NRL.

RESULTS

Based on analyses performed on the profile data we collected during the Littoral Optical Experiment, and with the collaboration of other investigators, we obtained the following results.

- Over time scales of a few minutes internal waves are a significant source of variability in the depth distribution of optical properties. There is evidence of internal waves vertically advecting the bottom nephloid layer and intermediate nephloid layers of biological and sedimentary particals. There is some evidence of Internal waves interacting with the sea floor causing resuspension of particles and the subsequent advection of those particles offshore by the bottom currents. Internal waves were also evident in the ocean color imagery collected during this experiment.
- The mean value of the beam attenuation coefficient increased towards shore and towards the sea floor (Figure 1). The variability also tended to increase slightly towards shore and towards the sea floor. Interestingly the variability of the surface water at the furthest offshore station was similar to that of the inshore stations. This was caused by the occasional advection of biological material from offshore past this location. This influence does not appear to have reached the second most offshore station. Mixing caused by surface waves and possibly the breaking of internal waves enhances variability at the inshore stations.
- The variability in optical properties measured 1 meter above the bottom at a station in 15 m of water could not be well explained by any of the hydrographic (wave height, tidal height, horizontal bottom currents) or meteorological (wind speed) data that was collected. The wave height data was the best correlated to the optical data over the duration of the experiment and could explain about 20% of the optical variability observed.

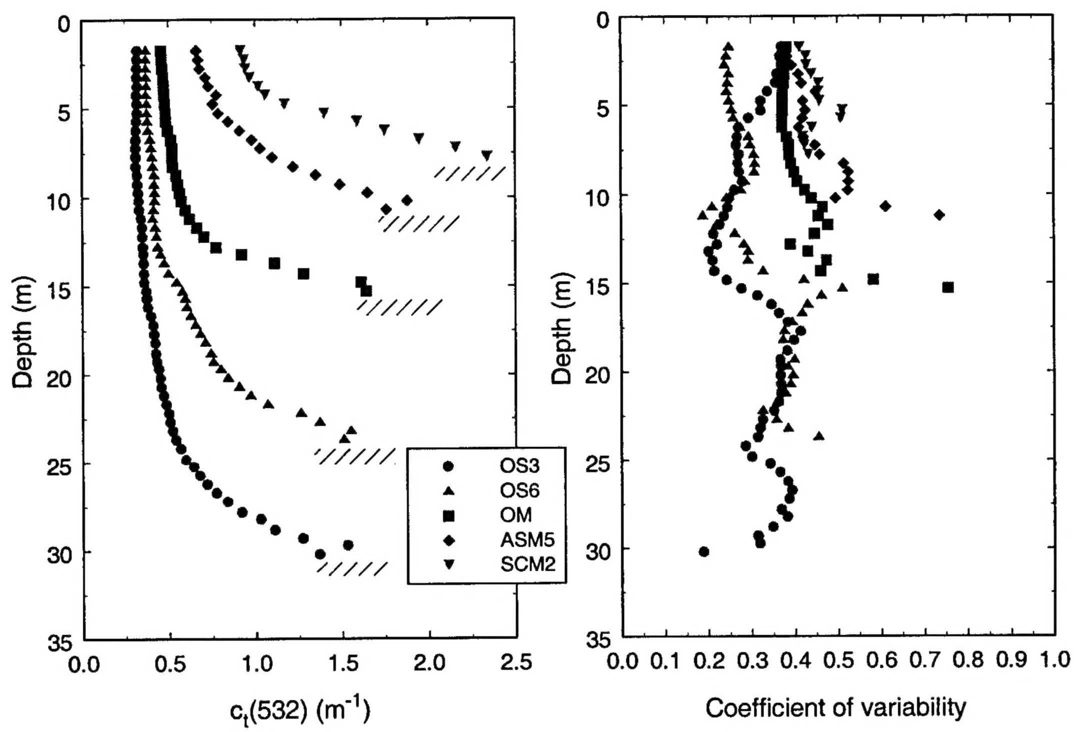

Figure 1. The first panel displays the mean attenuation profiles observed along the central transect line. The second panel is the coefficient of variability (standard deviation divided by the mean)calculated for the same set of profiles. Thirteen sets of profiles collected over eight days were used to determine the mean and coefficient of variability.

IMPACT/APPLICATIONS

Many of the present algorithms to determine bathymetry from passive remote sensing measurements assume that the optical properties of the water offshore can be used to estimate the reflectance contribution by water at the inshore stations. The gradient in optical properties towards shore and towards the bottom implies that this assumption is not valid at this location. It is also likely to be a poor assumption in many other regions.

Internal waves are important in determining the optical properties of the coastal region. Much of the optical variability that was observed at the mooring site may be caused by interactions between internal waves and the materials within the water column. Visibility models developed for the littoral environment must account for internal waves.

TRANSITIONS

Our data has been made available to our collaborators at NRL and is available to other investigators interested in this data. We have used the profile data to help interpret ocean color imagery collected at the Oceanside site.

http://photon.oce.orst.edu, OSU Ocean Optics home page; ftp://photon.oce.orst.edu, Anonymous ftp site